実験報告書様式(一般利用課題・成果公開利用)

(※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。)

J-PARC MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2014A0084 実験課題名 Title of experiment Chiral Helimagnetism in New Rareearth Inorganic Chiral Compounds: Yb(NiCu)$_3$Al$_9$ 実験責任者名 Name of principal investigator Jun Akimitsu 所属 Affiliation Aoyama-Gakuin University	装置責任者 Name of responsible person J. Suzuki 装置名 Name of Instrument/(BL No.) BL15 (TAIKAN) 実施日 Date of Experiment 2014/05/14 10:00:00 – 2014/05/20 10:00

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.
YbNi$_3$Al$_9$ (single crystal)

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。)
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

Our aim for this research topic is to investigate chiral helimagnetic ordering in new chiral magnetic compounds Yb(Ni,Cu)$_3$Al$_9$. The compounds have the chiral crystal structures belonging to a space group of *R*32, allowing Dzyaloshinskii–Moriya (DM) vector along the helical axis. Therefore, they are expected to form chiral helimagnetic ordering due to the competition between ferromagnetic exchange interaction and DM interaction, The pitch angle of the chiral helix is determined by the ratio of ferromagnetic exchange interaction and DM interaction due to spin-orbit coupling. In 3d electron system with very weak spin-orbit coupling, as a result, the period can be hundreds of angstroms. Therefore, high Q resolution is the key to detect the long periodic helimagnetic satellite peaks. On the other hand, the chiral magnetic materials with large spin-orbit coupling can form chiral helimagnetism with shorter period. YbNi$_3$Al$_9$, containing Yb as an rare-earth metal, shows helimagnetic ordering with the period of 34 Å along the *c*-axis, suggesting large amplitude of D due to strong spin-orbit coupling of rare-earth Yb sites.

In this experiments, we had two aims for the study of YbNi$_3$Al$_9$. The first one is to determine the chirality

2. 実験方法及び結果（つづき） Experimental method and results (continued)

of helimagnetic structure, which can be observed at (0,0,q). The second one is to detect the chiral soliton lattice, which can be observed at (0,0,2q) and/or (0,0,3q) as higher harmonics. The data was taken at the small- and wide-angle polarized neutron scattering instrument BL15 (TAIKAN) at MLF facility in J-PARC.

As for the first aim, we performed polarized neutron diffraction experiments with neutron polarization parallel and anti-parallel to the scattering vector. The scan profile of (0,0,*q*), we observed clear difference of magnetic satellite intensity as an evidence of chiral helimagnetic ordering domain ratio between the right- and left-handed spiral magnetic domains was not equal. As for the second aim, we performed unpolarized neutron diffraction experiments with changing amplitude of applied magnetic field perpendicular to the *c*-axis. However, we cannot see any higher harmonic indexed by (0,0,2*q*) and/or (0,0,3*q*). The problem may just come from too small signal of higher harmonics.

This experiments succeeded in proving chiral helimagnetic ordering in $YbNi_3Al_9$. As for the chiral magnetic soliton lattice, we plan to prepare a larger single crystal to observe the higher harmonics. As the next step, we will observe chiral incommensurate magnetic ordering in $Yb(Ni,Cu)_3Al_9$.

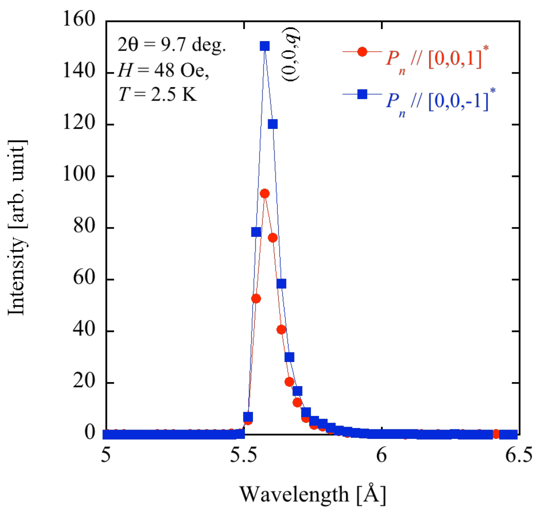

Fig. 1 Polarized neutron diffraction profile at the (0,0,*q*) reflection.

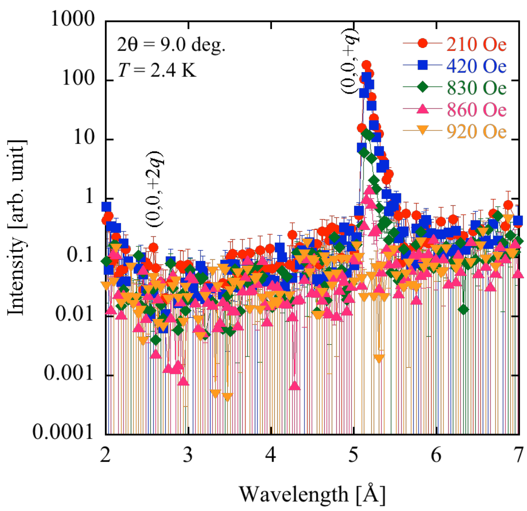

Fig. 2 Unpolarized neutron diffraction profile at the (0,0,*q*) and (0,0,2q) reflections.